

Performance Progress Report
Developing the Pacific Islands Ocean Observing System (PacIOOS)
Cooperative Agreement # NA16NOS0120024
Performance Period: June 1, 2016 through November 30, 2016

Submitted December 2016 by:
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This report covers activities conducted during the first six 6-month performance period of this award. PacIOOS’ estimated operating budget for the fiscal year is \$2,757,500.

1.0 Progress and Accomplishments

Waverider buoy operating in HI, Mariana Islands, American Samoa, and the Marshall Islands; Original completion date: Ongoing

***Status:** Ongoing. Keeping all 14 wave buoys managed by PacIOOS operational has proven to be a challenge this reporting period. PacIOOS has invested funds in another person to help maintain the wave buoys as well as to purchase spare mooring supplies to shorten the turn-around times when buoys break free from their moorings, but we still lack sufficient funds to purchase spare wave buoys, which would greatly enhance the ability of the team to shorten observational down-time. Unplanned operations this reporting period included redeploying Ritidian Point (Guam), Tanapag, Hanalei, and Barbers Point.*

Redeploy Majuro wave buoy; Original completion date: August 2016

***Status:** Complete. May 2016. Local partners, including the U.S. Ambassador to the RMI, held a local blessing for the buoy before it was deployed.*

Swap Saipan, Mokapu, and American Samoa wave buoys; Original completion date: November 2016

***Status:** Complete. Saipan – November 2016; Mokapu – September 2016; American Samoa – October 2016. Unfortunately, the Saipan buoy broke free from its mooring a few weeks before the planned buoy swap in August 2016. As a result, a new mooring had to be built and shipped. The new buoy was redeployed in November. The American Samoa wave buoy is currently out of the water. The buoy’s mooring was tampered with less than a month after the buoy was swapped with one with new batteries. The buoy was recovered, but a new mooring had to be built, the shipment of which has been delayed. Now the team has to wait for the availability of partners to help with the redeployment and a good weather window.*

Real-time wave data and associated products online; Original completion date: Ongoing

***Status:** Ongoing. New, interactive plots for wave data are now available on the PacIOOS website.*

Nearshore water quality sensors operating and data online; Original completion date: Ongoing

Status: Ongoing. PacIOOS currently has 6 near shore sensors operational in Hawai‘i, and 4 operational in the Insular Pacific. Partners on the islands other than O‘ahu are key to keep this operational and data flowing. Two sensors (where the partnerships were not optimal, or the site location was no valuable to stakeholders) have been pulled for a new PacIOOS effort called the PacIOOS Water Quality Sensor Partnership Program (WQSPP). Partners write short proposals to utilize the sensors for projects that range from 6-12 months long. We have supported such short-term projects in Lāna‘i (first pilot project), Palau, and Pohnpei. Because the next project in Palau ran into internal political issues, we are extending the project in Pohnpei and using the other sensor a non-profit group on O‘ahu obtain water quality measurements during a small harbor dredging. Partners and stakeholders are pleased with this new program and would like to see it expanded if resources become available.

The Kahului (Maui) near shore sensor is broken, and the costs to repair it are more than the initial cost of the sensor. As a result, the Kahului site has been discontinued. Disposition paperwork is currently being processed within UH and will be submitted to NOAA in January 2017.

Collection of validation samples at the MAPCO2 (Kāne‘ohe) buoy twice a month, conditions permitting, and return of these samples to the De Carlo laboratory for subsequent analysis of total alkalinity (TA) and dissolved inorganic carbon (DIC). Original completion date: Ongoing

Status: Ongoing. Validation sample collection has been largely on track, with the exception of an inability to go to the buoy for sample collection during bad surf/weather days. These are quite common at this site, as it is several miles offshore, exposed to the trade winds, and subject to very large N. Pacific waves during the winter months. All validation samples collected since the last reporting period have been analyzed for total alkalinity (TA), but dissolved inorganic carbon (DIC) analyses are pending repair of the coulometer in the SOEST Laboratory for Analytical Biogeochemistry (SLAB). It is anticipated that the coulometer will be available early in 2017.

Kāne‘ohe water quality buoy operating and data online; Original completion date: Ongoing

Status: Ongoing. Currently the Kāne‘ohe buoy is in harbor for annual maintenance and repair. The buoy broke free of its mooring around 1 December 2016, traveled across the Barrier Reef of Kāne‘ohe (suffering some structural damage) and settled on hardpan but coral free bottom on 2 December 2016. It was surveyed and instruments removed on 3 December 2016, and the buoy was subsequently recovered from the reef and towed into harbor (UH-HIMB facility) on 4 December 2016. The buoy will need some structural parts to be replaced, that will be provided by PMEL as soon as they are able to do so. It is anticipated that the buoy will be out of service for approximately two months.

Hilo Bay water quality buoy operational and data online; Original completion date: Ongoing

***Status:** Ongoing. This reporting period there was an intern at the UH Hilo campus working on a project to determine how to utilize the buoy data to provide a grade for the environment. The project entails developing justifications for how different parameters are weighted for specific environments.*

Deploy Pelekane water quality buoy; Original completion date: February 2017

***Status:** On-track. We have obtained the nationwide permit for the buoy deployment from USACE, and the team is now working on the environmental review by the USCG. There are questions from the USCG about the visual impact of the buoy, which we hope to resolve in early 2017 so that we can stay on track to deploy the buoy in February.*

Water quality data and products online; Original completion date: Ongoing

***Status:** Ongoing. New, interactive plots for water quality are now available on the PacIOOS website.*

Real-time surface currents available online for west and south shores of O‘ahu and Hilo Bay; Original completion date: Ongoing

***Status:** Ongoing. PacIOOS HFR have the best uptime in the U.S. – 93%. Focus during this reporting period has been on operations and maintenance of 7 HFR stations on O‘ahu and Hawai‘i Island. Additional cables have been laid at the Kapolei (Chevron) site. Additional antennae will be deployed soon. This improvement will bring the site from 8 to 24 antennae, increasing the resolution from 7-8 degree resolution to 3-4 degree resolution. Many of the HFR sites are aging and need repairs. New mapping interfaces containing real-time surface current information are now available on the PacIOOS website as well as PacIOOS Voyager.*

Ocean condition products online; Original completion date: Ongoing

***Status:** Ongoing. Interactive graphs and map viewers on PacIOOS’ new website provide a quick way to check PacIOOS’ latest observations and forecasts.*

High-water level forecasts available online; Original completion date: Ongoing

***Status:** Ongoing. Continuously refining forecasts with user feedback and collaborating with partners to obtain on-the-ground validation during predicted events.*

Harbor surge forecasts available online; Original completion date: Ongoing

***Status:** Ongoing. PacIOOS-supported PhD candidate graduated. Work ongoing to refine harbor surge forecast and obtain non-IOOS funding to expand locations.*

Wave run-up forecasts available online; Original completion date: Ongoing

***Status:** Ongoing. Submitted proposals outside of IOOS to expand locations of wave run-up forecasts within the region. Continuously refining forecasts with user feedback and collaborating with partners to obtain on-the-ground validation during predicted events.*

Coastal hazard data and products online; Original completion date: Ongoing

Status: Ongoing.

ROMS circulation model in operation for Hawai‘i, Mariana Islands, and Samoan Islands; Original completion date: Ongoing

Status: Ongoing. The team has been testing the newest version of the ROMS code, which will improve the model, causing less errors/bugs in the future. The team is also working on a 10-year re-analysis for the Main Hawaiian Islands ROMS grid. If there is server space available, they will do the same for other grids in the region. In addition, the team is working on an ensemble prediction that they hope to roll into operational-mode soon.

Model data and products online; Original completion date: Ongoing

Status: Ongoing. IOOS funding is supporting PacIOOS ocean circulation forecasts for Hawai‘i, Mariana Islands, and Samoan Islands. In collaboration with UH Hawai‘i Institute of Marine Biology (HIMB), PacIOOS also developed an interactive map viewer that allows users to explore the estimated coral cover around the Main Hawaiian Islands. Based on diver surveys and environmental datasets collected between 2000 and 2009, the study uses statistical distribution models to estimate coral distribution.

Ala Wai plume model online; Original completion date: Ongoing

Status: Ongoing. Plume model relies on real-time water quality data, ROMS ocean model, and SWAN wave model. Visual impact is significant after severe rain events.

Transmitting tags deployed on pelagics (sharks) throughout the year; Original completion date: Ongoing

Status: Delayed. New tags have been received. Deployments have been delayed due to extremely few weather windows during this reporting period.

Service land-based receivers for shark tags throughout the year; Original completion date: Ongoing

Status: Ongoing. Staff have been hired, and two of the five land-based receivers have been deployed on O‘ahu: Ka‘ena and Mt. Ka‘ala. Right of Entry permits for two additional receivers were delayed, but are now moving forward.

Conduct 2016 Governing Council Elections; Original completion date: August 2016

Status: Complete. August 2016. See more details below in Section 3.0.

Convene Governing Council meeting; Original completion date: November 2016

Status: Complete. November 2016. Members of the PacIOOS Governing Council (GC) gathered for the annual meeting in Honolulu, HI. Following detailed program updates, discussions focused on approving the draft outline of PacIOOS’ revised Strategic Plan, and filling in some key content for the external facing piece of the plan. The GC agreed that the plan should have a

high-level strategic framework that is provided to both internal and external partners and stakeholders and a more internal operational plan with more details on how to run the system and achieve the strategic goals in the framework. GC members from across the region represent various sectors and provide valuable feedback to help guide the future direction of the program.

Release new website; Original completion date: November 2016

***Status:** Complete. August 2016. PacIOOS launched its new website. The organization of content was completely restructured and a modern design was implemented to allow for easy data and information access, and to enhance the overall user-experience. Through a responsive design, the website adjusts to desktop, tablet and mobile sizes. The new website is built within a content management system and highly customized to feature PacIOOS data tools. Data visualizations were newly developed to integrate dynamic data plots and multi-functional map viewers.*

As part of the website launch, PacIOOS fully launched its new branding and logo. New outreach materials, data visualizations, and other products incorporate the new look and feel. Older materials are successively transferred.

Outreach with stakeholders on Hawai'i Island about location for former Kiholo water quality buoy; Original completion date: November 2016

***Status:** Delayed. While we have started the discussion with stakeholders regarding a new location for the Kiholo water quality buoy, the team has not been able to focus on this effort as much as necessary due to other travel and operational needs. In addition, some key partner organizations (e.g., Kohala Center) have had significant changes in leadership, so we are waiting for the new leaders to emerge and settle before we approach them on this topic. PacIOOS leadership and outreach components are working with the PacIOOS co-investigator on Hawai'i Island to re-schedule and re-invigorate this effort. Expected completion date is now May 2017.*

Ongoing outreach with stakeholders and partners to ensure meeting ocean data needs; Original completion date: Ongoing

***Status:** Ongoing. Communication with partners is ongoing via e-mail, phone calls, and meetings. Specific activities during this reporting period are listed below.*

Communications

- *PacIOOS continues to publish and distribute monthly e-newsletters; more than 130 new contacts were added to the newsletter mailing list, the majority of which signed up through a new subscription form on the new website; a total of 1530 recipients receive monthly updates.*
- *Increased public awareness and interest in PacIOOS with targeted, engaging press releases to announce continuation of grant funding; launch of the PacIOOS website; Alliance for Coastal Technologies collaboration; importance of American Samoa wave buoy.*

- *Increased number of web stories to share PacIOOS updates as well as new tools and data sets.*
- *Participation in Hawai'i Public Radio Bytemarks Café Show to announce new website (September 2016).*
- *Interview of PacIOOS shark expert for Top Ten Weather Mysteries TV show.*
- *Article published on stakeholder-driven priority setting in Marine Technology Society Journal special issue on ocean observing systems (June 2016).*
- *Chapter published on PacIOOS Data Management in Oceanographic and Marine Cross-Domain Data Management for Sustainable Development (October 2016).*
- *Congressional outreach to announce new 5-year award (June 2016).*
- *Continue to produce updated and relevant flyers and materials for workshops, conferences, partner meetings, and general outreach.*

Social Media

- *PacIOOS continues its presence on social media, in particular on Facebook and Twitter, with a post frequency of 1-4 posts per week.*
- *PacIOOS' Facebook page has more than 1,250 likes; Twitter following increased by 40% from the last reporting period to 250 followers.*
- *Popular posts included the launch of the new PacIOOS website, monitoring of very high sea levels in Palau, observation resources related to Hurricane Lester and Tropical Storm Madeline, IUCN World Conservation Congress coverage, and shark week fun facts.*

Collaborative Efforts/Events

- *Continue to run PacIOOS kiosks at University of Guam, College of Marshall Islands, Windward Community College, Kailua Sailboards & Kayaks, Maui Ocean Center, Dolphin Quest (Kohala Coast, Big Island), Mokupāpapa Discovery Center (Hilo), and Kaua'i Community College.*
- *Exhibits at community outreach events, including North Shore Ocean Fest, 10th Annual Kewalo Basin Park Clean-up, and Marine Educators Night*
- *Three presentations for Waikiki Aquarium's World Oceans' Month Lunch Time Lecture Series (June 2016); four presentations at Sundays at the Bay Outreach Seminars at Hanauma Bay, O'ahu (August 2016).*
- *Various presentations and support of NOAA activities at IUCN World Conservation Congress in Hawai'i (September 2016).*
- *Continue collaboration with UH Maui College to use PacIOOS Voyager lesson plan as classroom activity for oceanography lab; focusing on data relevant to students and real-world decision-making.*
- *Water quality team continues to mentor undergraduate college students and high school students to support sensor program.*

Internal performance metrics report; Original completion date: August 2016

Status: Complete. October 2016. Operational uptime was slightly below the 90% targeted metric due to mechanical and shipping issues of wave buoys and nearshore sensors. A new spare nearshore sensor is likely to increase uptime for future reporting periods. Operational uptime and spatial coverage of PacIOOS numerical models was above the 90% target. The operational uptime of the PacIOOS website and data services was above the 99% target. The overall number of unique pageviews on the PacIOOS website was slightly below the target. Because the new website minimizes page views to enhance the user experience, the Governing Council suggested staff look into alternative metrics for measuring website performance, such as sessions, number of users, etc. and to make a recommendation to possibly adjust the performance metric at the next GC meeting. PacIOOS improved overall system effectiveness, annually, across all components, and exceeded the target to increase the number of ocean and coastal data sets available via PacIOOS.

Participate in IOOS Federal Advisory Committee Meeting; Original completion date: October 2016

Status: Complete. October 2016. Chris Ostrander participated in the FAC meeting in Seattle, WA.

Maintenance of ship-based detection of tsunamis network; Original completion date: Ongoing

Status: Ongoing.

Additional activities not mentioned above that highlight regional observing system successes and occurred during this reporting period include the following:

- Combined page views of the PacIOOS website and PacIOOS wave buoy pages from NDBC, and CDIP total over 1.68 million. PacIOOS wave buoys accounted for over 2.9 million data requests and over 4.8 million RSS requests through NDBC during this reporting period.
- Over 4,300 unique visitors (via direct external access to our servers) accessed more than 1.2 million pages in our servers and transferred over 230 GB of data.
- PacIOOS leveraged funding from multiple sources, including UH SOEST, HNEI, ONR, University of Guam EPSCoR, and other NOAA offices (OCM, OAP, NWS).
- New partner data sets were added to the PacIOOS Voyager, including new dolphin and whale tracks from the Cascadia Research Collective (CRC).
- The CRIMP-2 and Kāneʻohe Buoys have been providing data that are extremely useful to ongoing research activities at UH (De Carlo PI), including most recently, whole reef metabolism studies conducted in collaboration with Dr. Andreas Andersson and his students from SIO. A part of this work has been to evaluate the whole reef calcification response and recovery from the 2014 and subsequent bleaching events. The buoys are also serving as test bed locations for other OAP funded activities by PMEL in which we are serving as partners.
- Collaborated with NOAA NCCOS to virtually convene resource managers and scientists from the Pacific Islands region to discuss climate thresholds in coral reefs and other coastal

habitats. PacIOOS convened two webinars for the purpose of collecting feedback to help inform an upcoming Request for Proposals from NCCOS.

- *Participated on the NOAA Pacific Island Regional Team (PIRT), NOAA Sentinel Site Program, NOAA Pacific Regional Outreach Group (PROG), NOAA Offshore Aquaculture Group, one NOAA American Samoa, NOAA Habitat Blueprint Program, and State of Hawai'i Ocean Resources Management Plan (ORMP) Working Group.*
- *Continued collaboration with the Hawai'i Office for Coastal and Conservation Lands and the UH Coastal Geology Group to address needs of the Hawai'i Interagency Climate Adaptation Committee.*
- *Partnering with NOAA Habitat Blueprint team for West Hawai'i to develop project page to inform the public on the efforts in the priority area and to enable access to related data.*
- *Continued discussions with Pacific Islands Regional Planning Body (RPB) on potential partnership with PacIOOS providing the data management backbone for the RPB.*
- *PacIOOS management and a PacIOOS co-investigator are participating on the IOOS HFR working group. Ongoing.*
- *PacIOOS participated in IOOS DMAC meeting in Washington, D.C. (June 2016).*
- *PacIOOS participated in IOOS Executive Committee meeting in Washington, D.C. (June 2016).*
- *PacIOOS participated in IOOS Fall Meeting in Anchorage, AK (September 2016).*
- *PacIOOS invited to participate in Asia-Pacific Economic Cooperation (APEC) meeting in Australia (September 2016).*
- *Strategic Planning efforts are continuing to update the 5-year PacIOOS Strategic Plan.*

2.0 Scope of Work

No changes to the project scope of work are anticipated.

3.0 Personnel and Organizational Structure

PacIOOS held 2016 elections in July 2016 to fill 5 seats on the PacIOOS Governing Council. New PacIOOS Governing Council Members include representatives from RMI EPA, Palau Office of Climate Change, and NOAA PIFSC (Regional). Re-elected members include representatives from Liquid Robotics, Inc. (HI), Western Pacific Regional Fisheries Management Council (Regional). PacIOOS added one new MOA partner during this reporting period: The Republic of Palau Office of Climate Change. The total number of MOA Signatories is now 54.

4.0 Budget Analysis

Spending for this award is on track with projected program expenditures. The University of Hawai'i Office of Research Services submitted a semi-annual financial report for the period

ending September 30, 2016, through Grants Online. That report showed total receipts of \$493,968.96.

As of December 1, 2016, internal budget tracking shows expenditures of \$1,066,556.12 representing a draw down of 38.5% of the Federal funding for this award.

Performance Progress Report Addendum (covering December 2015 – November 2016, unless otherwise stated)

Education and Outreach Inventory

The Education and Outreach Inventory has been updated with PacIOOS activities. Please see the Google Doc for responses.

https://docs.google.com/a/noaa.gov/spreadsheets/d/1xsgY6Qz1ldwsotma1nmRLWVsJne5BWnt0J6qQZi9_Xk/edit?usp=sharing

Data Management, Products, and Services

PacIOOS data management group (DMG) ensures the data collected by PacIOOS are stored and accessible to users via standard services. Progress and challenges toward addressing each data management requirement are described below. See PacIOOS Data Management System (DMS) Plan (2016) for details.

1. Open Data Sharing

PacIOOS adheres to the NOAA Data Sharing Procedural Directive. All real-time and near real-time data managed by PacIOOS are freely available through open services, without delay or restriction. Avenues for accessing the data are available through the PacIOOS website: <http://www.pacioos.hawaii.edu/data-access/servers/>. Geospatial data are served via GeoServer and OpenLayers. PacIOOS does not restrict access to any data it collects or serves. Metadata are provided for all data, and data are machine-readable.

2. Data management planning and coordination

PacIOOS ensures local data storage and is working with NCEI for permanent archiving of data. PacIOOS routinely updates our data management plan, which was also part of our successful certification package. The PacIOOS DMG enables activities within PacIOOS modeling groups. PacIOOS continuously strives to make improvements to the system to ensure that regional DAC maintenance is stable, reliable, and efficient. Funding is always a challenge when planning for long-term operations and maintenance, including of a DMAC system. Additional funding sources outside of IOOS are continuously being pursued in order to ensure continuity and stability of the DAC.

PacIOOS supports data management coordination by participating in the operations, maintenance, and evolution of the national DMAC subsystem, including attending annual meetings and joining webinars and conference calls throughout the year. PacIOOS actively participates in cross-regional data management policy and implementation plan development, when invited to do so. PacIOOS is willing to participate in national data management committees and forums.

3. Provision of data to the Global Telecommunication System (GTS)

PacIOOS does not actively send data to the GTS. However, data that go through the functional DACs (e.g., data from the PacIOOS wave buoys) are sent by the DAC to the GTS when appropriate.

4. Data access services

All PacIOOS data are made available via data access services. Direct, binary access is provided through standard open-source protocols. Our main service is OPeNDAP (Open-source Project for a Network Data Access Protocol), and the system is built around the Thematic Real-time Environmental Distributed Data Services (THREDDS) DODS Server (TDS). In accordance with IOOS requirements, PacIOOS has also employed Sensor Observation Services (SOS) for providing data from point measurements via the latest version of THREDDS ncSOS service. PacIOOS maintains several web-based data browsing and display tools for gridded, point, and geospatial data, including a Live Access Server (LAS) for gridded data. In addition, the Environmental Research Division's Data Access Program (ERDDAP) is used for a variety of services, including display and browse, and a Web Map Server (WMS) based on GeoServer, is used to serve geospatial data.

5. Catalog registration

All PacIOOS data have complete and accurate metadata. These metadata are provided in a web accessible folder (WAF) that is read by various catalog services, including the IOOS catalog service.

6. Common data formats

PacIOOS offers data in IOOS-approved common data formats, including but not limited to, NetCDF, flat IEEE binary, ASCII, CSV, HDF, GRIB, and GIS formats. Our format is consistent with the NCEI netCDF templates.

7. Metadata standards

PacIOOS data sets conform to the Federal Geographic Data Committee (FGDC) and/or ISO 19115. A python-based PacIOOS web catalog service (pyCSW) provides access to all metadata with query capabilities. All our metadata are in a WAF and catalog service.

8. Storage and archiving

Local storage for data streams is on a Redundant Array of Independent Disks (RAID) system, which is essentially a single unit with multiple hard drives with data stored redundantly across the disks, so in the event of a hardware failure on a single disk data are preserved on another. In addition, all PacIOOS data are replicated across mirrored RAID systems. PacIOOS is currently working with NCEI to ensure archiving of PacIOOS data. The solution will be to use the PacIOOS ERDDAP server to provide data to the PacIOOS WAF, and then NCEI can harvest the data from there. At present we are

experimenting with an initial data stream. Challenges incorporating all the suggested metadata, along with changing QARTOD specifications, have caused delays. Storage and archiving of data that go through a functional DAC from PacIOOS are handled by each respective functional DAC.

9. Ontologies, vocabularies, common identifiers

The PacIOOS DM sub-system employs a service-oriented architecture (SOA), built on controlled ontologies, vocabularies and identifiers, that enables six essential functions: 1) data storage, 2) metadata management, 3) data discovery tools, 4) data transport servers, 5) on-line browse capabilities, and 6) data quality assurance/quality control (QA/QC). The vocabularies used for geophysical data adhere to the netCDF Climate and Forecast (CF) conventions. Biological data use the IOOS Biology Standard that is based on Darwin Core.

10. Consideration for Long-term Operations

PacIOOS aims to maintain and enhance a system that will persist long-term. Changes to the IOOS DMAC policies and procedures, such as QARTOD updates, will be incorporated as necessary. While PacIOOS has implemented, and will continue to implement automation in the system (through programming, etc.) as much as possible, there will also be a need for experienced, knowledgeable personnel. Federal requirements, software, stakeholder needs, etc. are always changing, and automation cannot always appropriately accommodate such evolutions. Funding, therefore, is always a key consideration when planning for short- or long-term activities. PacIOOS' strategic goals moving forward, therefore, include the need to diversify and expand funding and leveraged resources to create a resilient and robust financial foundation. Additional funding sources outside of IOOS are continuously being pursued in order to ensure continuity and stability of the DAC. This is an ongoing challenge.

Observing Assets

1. RA Observing Asset Inventory

Please see the attached Observing Asset Inventory spreadsheet for PacIOOS.

2. HFR Operations and Maintenance progress

Please see the attached spreadsheet for an annual update on HFR expenditures. Also, please see the attached annual update on HFR assets and staffing.

3. Annual Glider Days Inventory

Please see the attached Annual Glider Days Inventory spreadsheet.